Assessing the association between thinking dispositions and clinical error

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ABSTRACT

Background

Dual-process theory suggests that Type 1 thinking results in a propensity to make 'intuitive' decisions based on limited information. Type 2 processes, on the other hand, are able to analyse these initial responses and replace them with rationalised decisions. Individuals may have a preference for different modes of rationalisation, on a continuum from careful to cursory. These 'dispositions' of thinking reside in type 2 processes, and may result in error when the preference is for 'quick and casual' decision-making.

Methods

We asked clinicians to answer a cognitive puzzle to which there was an obvious, but incorrect, answer, to measure their propensity for 'quick and casual' decision-making. The same clinicians were also asked to report the number of clinical errors they had committed in the previous two weeks. We hypothesized an association between committing error and settling for an incorrect answer, and that the cognitive puzzle would have predictive capability.

Results

Ninety of 153 (59%) clinicians reported that they had committed error, while 103 (67%) gave the incorrect 'intuitive' answer to the cognitive puzzle. There was no statistically significant difference between clinicians who committed error and answered incorrectly, and those who did not and answered correctly ($\chi 2$ (1, n=1153)=0.021, p=0.885).

Conclusions

The prevalence of clinical error in our study was higher than previously reported in the literature, and the propensity for accepting intuitive solutions was high. Although the cognitive puzzle was unable to predict who was more likely to commit error, the study offers insights into developing other predictive models for error.

Introduction

Solutions to medical error are more likely to lie in cognitive science rather than in medical science.[1] The advantage to explaining errors in the light of underlying cognitive mechanisms is that understanding of these may lead to effective preventive measures. There is now a mature body of evidence that decision-making is the result of dual system thinking, and although there is some criticism of this theoretical model, there is sufficient empirical evidence to support it.[2] Thinking is believed to be the result of two distinctive processing types - type 1 processes are rapid and autonomous, and characterized by offering default responses; and type 2 processes are slow and deliberative, and capable of reflecting on the responses and either modifying or rejecting them in favor of a more or less rationalised response. The former results in minimal cognitive load, whereas the later is load intensive.

Notwithstanding the arguments for different terminologies relating to the underlying processes, we shall refer to the parts interchangeably as type/system 1 processes and type/system 2 processes. Type 1 processes tend to be associative and have minimal requirement for working memory. Importantly, these processes are also responsible for implicit learning and therefore give rise to the automatic responses of highly learned associations, where the associations that result from repeated experiences are dominant to the point of automaticity.[3]

Some workers describe a 'toggling' function between type 1 and type 2 processes and that the ultimate decision is a blend of type 1 and type 2 processing – indeed the optimal decision-making strategy is the correct 'dose' of the two systems.[4] However, another school of thought separates type 2 processes into two distinct *modes* of thinking, which describe *thinking dispositions* of type 2 processing.[5] The modes share the characteristic of always requiring working memory, but the styles of thinking may be anywhere on the continuum of slow and careful to quick and casual, and they constantly vary.[2] Modes of thinking also differ between individuals, personalities, and different cultures.[6,7]

Conceptually therefore, there is a trio of 'minds' – the autonomous mind (type 1 processes), the algorithmic mind (responsible for complex computation), and the reflective mind (responsible for weighing choices).[2] These minds display a hierarchical structure of control. The autonomous mind can be overridden by the algorithmic mind, which in turn is subordinate to the reflective mind, the highest level of regulation (figure 1).

This tripartite model is an extension of the dual processes model of cognition, and explains 'irrationality' in decision-making, with the reflective mind as its locus. Intelligence and rationality are separate constructs. The computational ability associated with our traditional understanding of intelligence and the ability to perform in IQ tests is directly attributable to the algorithmic mind. It is determined by the cognitive capacity of individuals, i.e. the working memory capacity, which is highly correlated with IQ. In contrast, the reflective mind is a thinking disposition that has the capability to collect and weigh up information before coming to a decision.[5]

The relationship between system 1 and system 2 is best characterised as *default-interventionist*,[8,9] where type 1 processing generates a default response, while type 2 processes have the facility to intervene. There is therefore the potential for intuitive responses to be overridden and replaced by reflective reasoning. However, the tendency to override relies on several factors, for example the strength of confidence in the intuitive response.[3] This does not require accuracy of intuition, merely confidence. Another factor influencing the overriding of system 1 is the thinking disposition of the reflective Mind. System 1 is always switched on, and intervention will only kick in to exert the effort of using working memory if it has to – in conditions of difficulty, higher motivation or novelty.

From experimental data in the field of cognitive psychology, it has been found that certain simple logic puzzles can be predictive of a predisposition for system 2 thinking to be overconfident when presented with 'intuitive' solutions. One such puzzle is shown below (based on the 'bat and ball' puzzle), which offers an intuitive (but incorrect) response of 10mg.[10]

> The dose of a combination drug (Drug A + Drug B) is 110mg
> Drug A is 100mg more than Drug B
> What is the dose of Drug B?

The immediate response of 10mg is the result of system 1's acceptance of the 'obvious' answer, which system 2 has the opportunity to reject or accept. Acceptance implies an unwillingness of system 2 to expend the effort of using working memory to reflect on and compute the correct answer. Although the mind has the option to apply rationality to intuitive judgments, a feature of type 2 thinking is that it is inherently 'lazy' and is therefore susceptible to suggestions from system 1, particularly when these are made confidently. This is despite system 1 intuitions being inaccurate under conditions of high uncertainty. In a clinical context this may conceivably result in incorrect clinical decisions, which lead to errors of judgment. The 'laziness' of type 2 processes may be explained by a preference for a quick and casual mode of thinking originating in the reflective mind.

If this thinking disposition is indeed a preference in the same way as handedness is, then it may be postulated that the resulting decision-making in conditions of complexity could theoretically lead to error more frequently. Knowing this propensity would enable individual clinicians with this preference to heighten their vigilance to committing error or even rationalise career choices to roles less exposed to dynamic and unpredictable environments.

This study has the twofold aim of assessing the propensity of clinicians to opt for a superficially correct answer to this cognitive puzzle, and their self-reported rate of committing clinical error. We aimed to test for an association between incorrect answers to the puzzle and committing recent clinical errors. We hypothesised that the cognitive puzzle may be predictive of susceptibility by the reflective mind to cognitive errors, and that this susceptibility may manifest itself in clinical errors. An accepted taxonomy of errors is defined using Reason's classification of slips, lapses, mistakes and violations, based on the clinician's 'intention', and in answer to the questions; were the actions directed by a prior intention?;

Did the actions proceed as planned?; Did they achieve their desired end?[11] Based on this definition, error can be classified as:

- Slips: actions not carried out as intended or planned, e.g. inadvertently dialing the wrong number.
- Lapses: missed actions and omissions, i.e. forgetting something owing to lapse of memory or inattention.
- Mistakes: caused by a faulty plan/intention, i.e. making a wrong decision or doing the wrong procedure.
- Violations: deliberate illegal actions, i.e. performing acts that are known to be 'against the rules'.

Violations were excluded as a cause of error from this study since it implies a *conscious* decision to commit the error, rather than the error resulting from faulty cognition.

Methodology

A questionnaire was designed to include the two 'critical' questions of how many errors were committed by responding clinicians in the past two weeks (with definitions provided), and the cognitive puzzle shown above. Two more clinical questions were included to lessen hypervigilance to the cognitive puzzle, and so promote a type 1 thinking process.

The study sample was drawn from a cohort of clinicians attending simulation-based training courses at our institution. These clinicians were invited to participate in the study after a description of its aim to assess thinking style and its association with error.

Ethics

Anonymity was guaranteed and participants who did not wish to participate could return their questionnaires blank without the researcher being aware of their non-participation. In this way responding and non-responding clinicians could not be distinguished by the researchers. Full ethics approval was obtained from the Faculty Research Ethics Committee of Anglia Ruskin University (FREP 16/17 083).

Statistical analysis

All data was treated as categorical, and a Chi Square test was used to compare groups, with an *a priori* level of significance (alpha error) set at 0.05. The end points measured were self-reported errors and the number of clinicians settling for the incorrect answer to the cognitive puzzle.

Results

There were 153 participants invited to take part in the study, with 153 completed returns (response rate 100%). Of these, 90 (59%) reported committing an error in the past two weeks, and 103 (67%) provided an incorrect answer to the cognitive puzzle. Where some respondents (2, 1.3%) did not provide an answer but stated that 10mg was incorrect, we categorised these as correct since they were clearly alerted to the falsity of the 'obvious' solution. When grouped as those giving the correct answer versus those giving an incorrect answer, the number of participants committing or not committing error is shown in Figure 2.

Cross-tabulation was performed with the different groups (table 1), and the chi square test failed to show a statistically significant difference between the groups ($\chi 2$ (1, n=1153)=0.021, p=0.885).

Table 1. Cross tabulation of respondents who answered the cognitive puzzle correctly and incorrectly, and who committed error in the previous two weeks.

		Answer		Total
		Correct	Incorrect	
Committed error	No	21 (33%)	42 (67%)	63 (41%)
	Yes	29 (32%)	61 (68%)	90 (59%)
Total		50 (33%)	103 (67%)	153 (100%)

Discussion

A large number of clinicians reported having committed at least one clinical error in the previous two weeks compared with reports in other studies. Wu et al found that 45% of surveyed house officers reported committing an error, which included the categories of diagnostic (33%), prescribing (29%), evaluation (21%), communication (5%) and procedural (11%) errors.[12] For diagnostic errors alone the range has consistently been found to be around 10 – 30%,[13] and for prescribing error a rate of around 7%.[14,15] Since the seminal Institute of Medicine report in 2000,[16] which gave prominence to the issue of medical error there has been an acceptance that it is something to be admitted to and spoken about, and our high number may reflect a growing willingness by clinicians to admit their own fallibility as part of a systems failure.

A significant majority of clinicians provided an incorrect answer to the cognitive puzzle. There are no previous data to provide a reference for this performance, except a range of 50 – 80% incorrect responses by US university students to the original 'bat and ball' puzzle.[10] However, given that the puzzle has been presented in a medical context, it may be argued that it behaves as a surrogate of a drug calculation and reflects the potential for committing errors of prescribing. However, the question is not validated to perform this function, but may form an interesting line of investigation.

An observation that was not a formal part of the study, but was made by the researchers was that several of the respondents who answered correctly appeared to display a realization that 'something was wrong', before calculating the correct answer. Although this study did not set out to measure any actual processes used to arrive at the answer, this observation of an internal alarm sounding offers a potential route of investigation for measures to counteract a 'lazy' thinking mode. This phenomenon of an internal alarm could be a sign of cognitive 'dis-ease' (or cognitive strain),[10,17] which provokes a cautious disposition of type 2 thinking. A principle step in Type 2 processes overriding system 1 intuitions is this process of metacognition, which only occurs when system 2 is alerted to the possibility that all is not well and system 1 may be wrong.[18] The implication is that a potential solution to 'lazy' thinking is to induce cognitive dis-ease, and so trigger a cautious and analytic disposition. The concept has been proposed as a 'debiasing' strategy. Although debiasing strategies are not universal and need to be customized for particular biases,[4] the starting point of sparking vigilance may be universally applicable. Raising awareness of the potential for bias in clinical decision-making is the first step to clinicians correcting themselves.[19]

The number of clinicians committing error *and* opting for the incorrect answer was not significantly different to those not committing error and giving the incorrect answer. There may be a number of reasons for this non-significance, including an insensitivity of the cognitive puzzle to detect a quick and casual thinking disposition, self-reporting of error not accurately reflecting true rate of error, or indeed the non-association proving the null hypothesis of there being no association. The other possibility is that thinking dispositions may not be stable in individuals and may change with context. While the algorithmic mind has trait-like characteristics (and is stable), the reflective mind may have state-like elements that change with circumstance.[6] Therefore, thinking dispositions may change under different conditions, for example with changing cognitive load. The cognitive puzzle was administered under the conditions of a 'classroom test'. If administered under conditions similar to the more dynamic and stressful clinical conditions in which error often occurs, it may achieve predictive capability.

There are limitations to this study. Error was self-reported, with the potential for inaccuracy through under-reporting and hindsight bias. However, this is likely to result in underestimation so that the reported frequency is a conservative estimate of the true frequency. Thinking disposition may be context-sensitive and, as indicated, the puzzle was administered under different condition to those the errors may have occurred in.

Conclusions

Dual process thinking is commonly described as a straightforward relationship between system 1 and system 2, with potential solutions being 'debiasing strategies' that subject intuitive judgements to type 2 analytic scrutiny. This view sees type 2 processes as being 'reliable, safe and effective'.[4] However, type 2 processes are not necessarily consistent, either within or between individual clinicians. Theorising that Type 2 thinking displays 'dispositions' that occupy a spectrum between quick and casual to slow and careful, begs the question of whether these preferences are stable and can be predicted, and therefore may suggest strategies that can be tailored to individuals and contexts.

No other study has attempted to describe an association between 'failure' of the reflective mind of system 2 as demonstrated by incorrect completion of a cognitive test, and propensity to committing clinical error. Even though this study did not show such an association it is still plausible, but may need a different approach to demonstrate it. What this study has shown is a very high rate of reported clinical error, as well as a high susceptibility for clinicians to accept type 1 suggestions, which suggests that further investigation should be undertaken to search for an association. At the very least this study's negative results point to different directions that should be explored. Future investigations should test thinking dispositions in near-authentic conditions in a simulated environment. A simulated clinical environment can provide a dynamic clinical problem that may offer 'intuitive', but suboptimal, solutions, that would lead directly to error if taken. In this way causality between decision and error can be demonstrated. Also, it more closely replicates the 'flesh and blood decision making' that occurs in clinical environments,[11] rather than it being a purely cognitive exercise.

Main messages

- Two thirds of practicing clinicians report having committed a clinical error in the previous 2 weeks.
- Two thirds of practicing clinicians display a 'quick and casual' thinking disposition when faced with a cognitive puzzle.
- Tests of thinking disposition should occur in contexts that replicate conditions predisposing to error.

Current research questions

- Can predisposition to committing clinical errors be predicted by using cognitive tests of decision-making?
- Are thinking dispositions that are used for clinical decision-making a stable trait-like phenomenon, or do they change with the context of the decision?
- Will inducing cognitive dis-ease (strain) change a thinking disposition to result in fewer errors?

Figure legends

Figure 1. The hierarchy of minds in System 1 and System 2 processes. The arrows indicate the direction of control.

Figure 2. Bar chart showing how many respondents who answered the cognitive puzzle correctly and incorrectly committed error in the past two weeks.

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